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VELOCITY UNIFORMITY AND PIEZO-ELECTRIC GAUGE
RECORDS OF VARIOUS TYPES OF CHARGE FOR THE 10" GUN

by

R. H. Kent

April 1936

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13 November 1995

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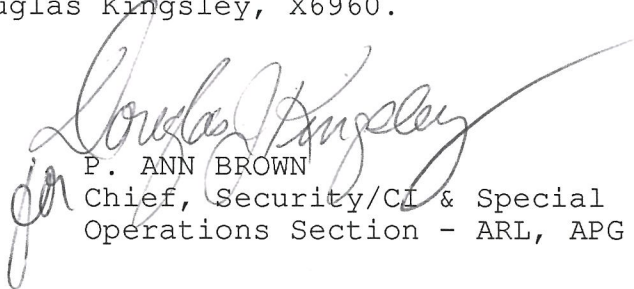
1. Reference: BRL Report No. 47, "Velocity Uniformity and Piezo-Electric Gauge Records of Various Types of Charge for the 10" Gun", by R. H. Kent, April 1936.

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4. Our action officer is Douglas Kingsley, X6960.


P. ANN BROWN
Chief, Security/CI & Special
Operations Section - ARL, APG

RHK/emh
Aberdeen Proving Ground, Md.
April 16, 1936

VELOCITY UNIFORMITY AND PIEZO-ELECTRIC GAUGE RECORDS
OF VARIOUS TYPES OF CHARGE FOR THE 10" GUN

In Connection with Project KW 250 - Study of the -
Factors Involved in the Design of Propelling Charges.

Abstract

Piezo-electric gauge records were taken of the pressure of single section and two section unstacked charges and also of four section stacked charges. It was found that the four section stacked charge was the only type that gave smooth pressure-time curves. The velocity dispersion for this type of charge was much smaller than for the other ones.

Introduction

A number of charges of different types were fired in January and February 1936, in the 10" gun in connection with O.P. 's 5240 and 5310. Piezo-electric gauge records of some of these rounds were obtained. The object of this report is to discuss the velocity uniformity results obtained in the light of the character of the piezo-electric gauge records.

Piezo-electric gauge apparatus

Piezo-electric gauge records were taken for each type of round. These were the first records in which the cathode ray oscillograph was used to record the pressures of guns more

remote from the Instrument Building than the Main Front. Dr. Hodge built an amplifier which was placed near the gun. The output was taken directly to the cathode ray oscillograph for the firings on January 17.

It was found that there was a considerable distortion of the calibration records made on this date. This lead to a study of the theory of the propagation of waves along wires, a theory which was developed many years ago by Heaviside, Poincare' and others. In the light of this theory it was found that the waves are reflected at the practically open end of the circuit at the plates of the oscillograph. It was seen that to prevent the reflection of these waves, it was necessary to have the end of the line shunted by a resistance which is approximately equal to the impedance of the line per cm., about 300 ohms. This made it necessary to introduce a second amplifier near the oscillograph, the output of which was impressed on the plates of the cathode ray oscillograph.

The system seems to have a tendency to oscillate which is probably the cause of the broadening of the lines as shown in some of the records obtained in the firings of February 19.

Although the records obtained on the whole are considered rather promising some more development will have to be made before they can be depended upon for quantitative purposes.

Results

The velocity results obtained with these charges and other details are given in the attached firing records Nos. 8794 and 8833. From the firing records, it may be seen that the mean deviations in velocity for the three types of charge are as given in the table below:

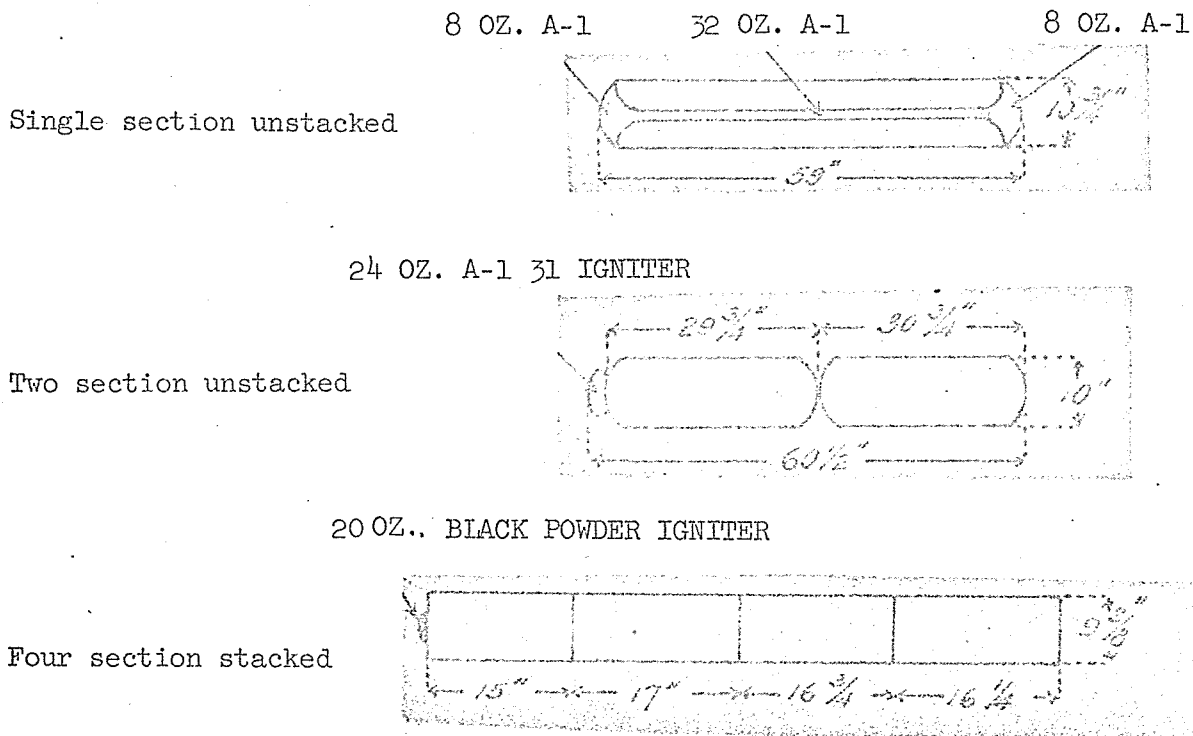
Type of Charge	No. of Rds.	Mean Deviation in Velocity * f/s
Single section unstacked	4	18.5
Two section unstacked	5	9.4
Four section stacked	4	3.3

* Solenoid velocities only considered.

Diagrams of the types of charge are shown in fig. 1.

Type of Charge

Diagram



The diameter of the chamber is 11.8 inches.

Fig. 1.

Copies of the piezo-electric gauge records are attached.

Discussion

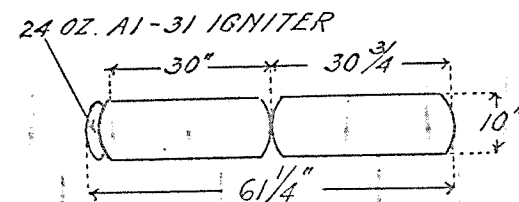
It may be seen that with the unstacked charges, pressure waves of appreciable amplitude occurred and there does not seem to be much difference between the amplitude of the waves produced by the two types of charge. On the other hand the oscillations of the pressure-time curves obtained with the stacked 4-section charge are much smaller than those obtained with the other types of charge. As has been stated the mean deviation obtained with the stacked charges was much less than the mean deviation for either type of unstacked charge. This result confirms the results obtained in the 155 mm Gun G.P.F. (See Report No. 45) and also the results obtained in the 75mm Gun 1897 and the 3" Gun

Model 1917, namely, that if a type of charge has a large dispersion in velocity and also appreciable pressure waves, a change in the method of ignition or arrangement of the charge which reduces the amplitude of the pressure waves, will also reduce the dispersion in velocity.

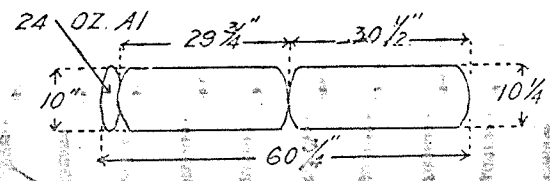
R. H. KENT

H. H. Zornig,
Lt. Col., Ord. Dept.,
Chief Research Division

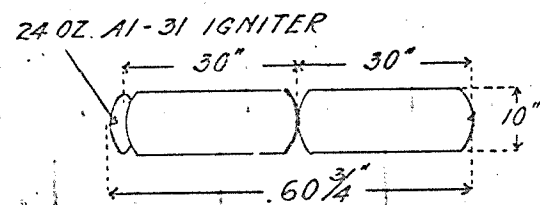
10" GUN NO.42 1888 MII
RD 16 11/17/36
157 LBS 4 OZ DPX 3545-1918.
Pmc = 34900
Vo = 2269



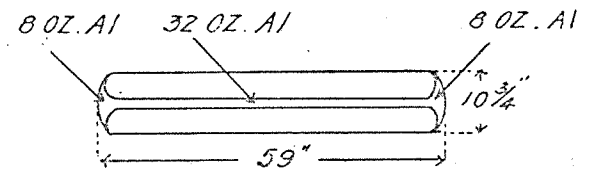
10" GUN NO.42 1888 MII
RD 16 11/17/36
157 LBS 4 OZ. DPX 3545-1918
Pmc = 34200
Vo = 2262



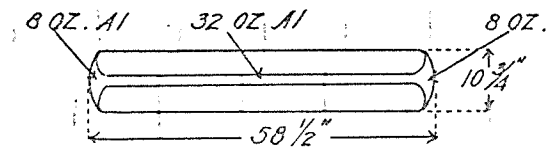
10" GUN NO.42 1888 MII
RD 20 11/17/36
157 LBS 4 OZ DPX 3545-1918
Pmc = 33800
Vo = 2261



10" GUN 1888.
CHARGE 157 LBS 4 OZ DPX 3545-18 2 SECTION

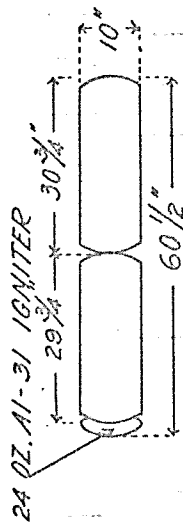


10" GUN NO. 42 1888 MII
 RD 15 1/17/36
 155 LBS 40Z DP 2416-18
 Pnc = 35,700

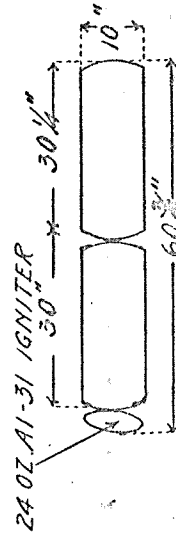


10" GUN NO. 42 1888 MII
 RD 15 1/17/36
 155 LBS 40Z DP 2416-18
 Pnc = 35,700
 V₀ = 2271

10" GUN 1888
 CHARGE. 155 LBS 40Z DP. 2416-18. SINGLE SECTION.

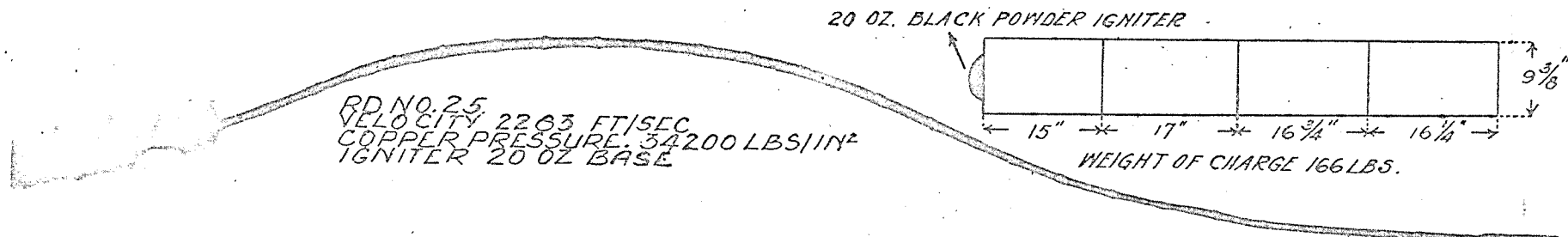


10" GUN NO 42 1888 MI
 RD 14 157 LBS 40Z DP X 3345-1918
 Pmc = 33700
 V₀ = 2249

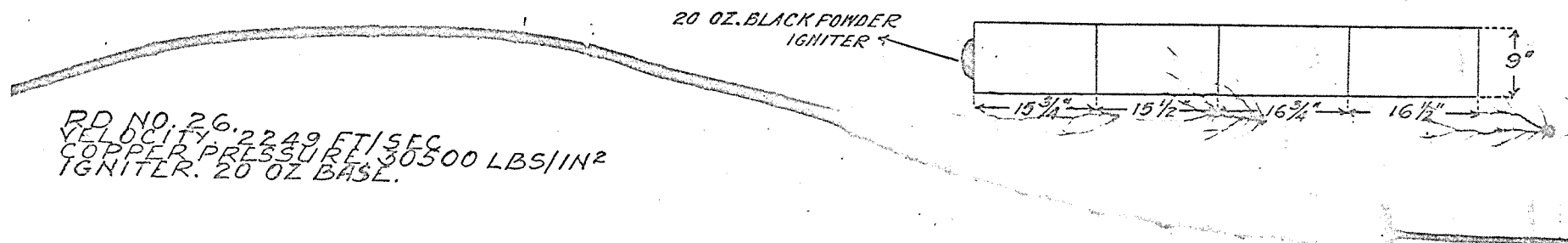


10" GUN NO. 42 1888 MI
 RD 14 157 LBS 40Z DP X 3345-1918
 Pmc = 34500
 V₀ = 2257 FT/SEC

10" GUN 1888 MI SECTIONAL



POWDER. 166 LBS 701 A

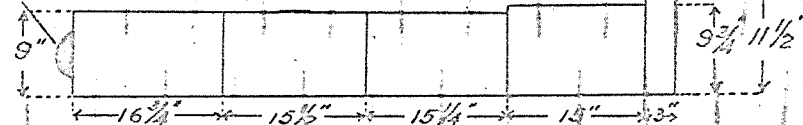


POWDER. 163 LBS 701 A

10" GUN NO. 42. MODEL 1888 MII
FIRED. FEB 19, 1936.

RD NO. 27
 VELOCITY 2345 FT/SEC
 COPPER PRESSURE 38500 LBS/IN²
 IGNITER 20 OZ BASEL

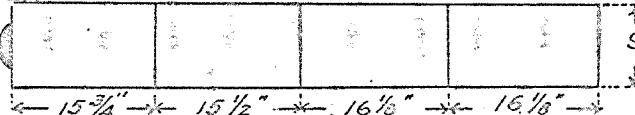
20 OZ. BLACK POWDER IGNITER



POWDER. 171.25 LBS 701A.

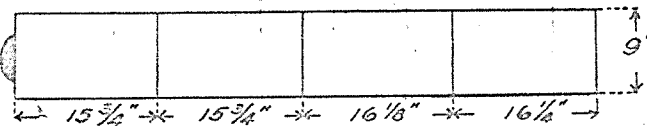
RD NO. 28
 VELOCITY 2249 FT/SEC
 COPPER PRESSURE 32200 LBS/IN²
 IGNITER 20 OZ BASEL

20 OZ. BLACK POWDER
 IGNITER



POWDER. 163 LBS 701A.

20 OZ. IGNITER



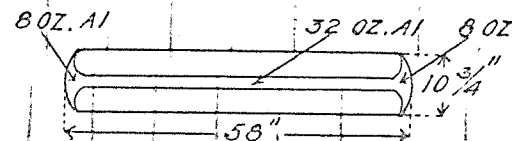
RD NO. 29
 VELOCITY 2240 FT/SEC
 COPPER PRESSURE 32300 LBS/IN²
 IGNITER 20 OZ BASEL

POWDER. 163 LBS 701A

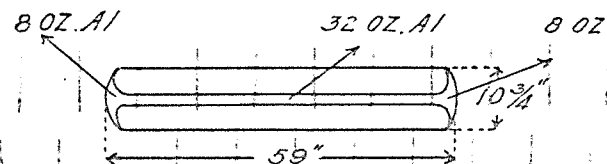
10" GUN NO. 42. MODEL 1888M11.

FIRED FEB 19 1936

10" GUN NO 42 1888 MI
 RD 17 117136
 155 LBS 40Z DP 2416-18
 $P_{mc} = 36,200$
 $V_0 = 2305 \text{ FT/SEC}$



10" GUN NO 42 1888 MI
 RD 19 117136
 155 LBS 40Z DP 2416-18
 $P_{mc} = 40,200$
 $V_0 = 2547$



10" GUN 1888.
 CHARGE. 155 LBS 40Z DP. 2416-18 SINGLE SECTION

STANDARD SPECIFICATIONS

Original Order: Special Test of Propelling Charges, Jan. 17, 1936
 DuPont Pyro Powder Lot X-3545 of 1918 8794
 for 10" Gun Model 1888-1895 (Register No. 571) 5

ACCEPTANCE

Ball No. 5376

5240
 471.55/213
 471.55/7-1
 3537-1

10" Gun	1888 MII	Beth. Steel Co.	42	10
10" Barbetto	1893	Morgan Eng. Co.	6	

33°
 Plate Range - Right

C.I. Target Practice Shell, Model 1911. Tredgar Co.'s Lot 10430-1
 (Width of Band 3-5/16". Distance from band to rear of base 1-5/8").
 Band is approximately the same as shown on Dwg. 75-9-11

None

None

None

Du Pont Co.'s Pyro Lot 497A-1917 for 10" Gun, M-1888-1895
 Du Pont Co.'s Pyro Lot X-2416-1913 for 10" Gun, M-1888-1895
 Du Pont Co.'s Pyro Lot X-3545-1918 for 10" Gun, M-1888-1895

Rds. 11 - Two Section. Dwg. 71-9-136
 Rds. 12, 14, 16, 18 & 20 - Two Section
 Rds. 13, 15, 17 & 19 - Single Section. Dwg. 71-9-12

Rds. 11, 12, 14, 16, 18 & 20 - 24 ozs. Gr. A1 Black Powder in Pad at Base of Base Section.
 Rds. 13, 15, 17 & 19 - 48 ozs. Gr. A1 Black Powder (8-32-3)

Seacoast Electric Lot 2471-3

GENERAL DATA BY ROUNDS

1936 DATE JAN.	ROUND NO.	TIME OF FIRING	PROJECTILE			POWDER			ELEVATION Deg.	FINAL CORRECTED		M. V. Boul.
			APG No. SS	WEIGHT AS FIRING lbs.	Recoil Ins.	Lot	Box No.	CHARGE WEIGHT lbs. ozs.		PRESSURE	VELOCITY Sol.	
17	11	11.16	W18	617	43-1/2	497A		139 0	1	27300	2039	2042
	12	11.40	W19	"	43-1/2	X-3545		157 4	"	33700	2250	2249
	13	11.57	W20	"	43-3/4	X-2416		155 4	"	36900	2307	2309
	14	12.32	W21	"	43-1/2	X-3545		157 4	"	34500	2252	2257
	15	12.46	W22	"	43-1/2	X-2416		155 4	"	35700	2269	2271
	16	12.58	W23	"	43-1/2	X-3545		157 4	"	35000	2268	2269
	17	1.10	W24	"	43-1/2	X-2416		155 4	"	36200	2298	2305
	18	1.20	W25	"	43-1/2	X-3545		157 4	"	34200	2261	2262
	19	1.29	W26	"	43-1/2	X-2416		155 4	"	40200	2334	2341
	20	1.40	W27	"	43-1/2	X-3545		157 4	"	35900	2280	2281

RD. 11 - Warning Round.

Seating Inches-Rd. 11 - 91-1/8" - All other rounds 91-1/4".

The gun remained out of battery on Rd. 11 -3/8", Rd. 12 -11/16", Rd. 13 -7/8"
Rd. 14 -3/4", Rd. 15 -1", Rd. 16 -1-1/4", Rd. 17 -1-3/8", Rd. 18 -1-1/2", Rd. 19
-1-5/8", Rd. 20 -1-5/8".

RD.	Section 1		Dimensions of Charge		Total length
	Diameter	Length	Diameter	Length	
11	10-3/4"	28"	10-3/4"	29	57-1/2"
12	10"	29-3/4"	10"	30-3/4"	60-1/2"
13	10-3/4"	59"	"	"	59"
14	10"	30"	10"	30-1/4"	60-3/4"
15	10-3/4"	58-1/2"	"	"	58-1/2"
16	10"	30"	10"	30-3/4"	61-3/4"
17	10-3/4"	58"	"	"	58"
18	10"	29-3/4"	10-1/4"	30-1/2	60-3/4"
19	10-3/4"	59"	"	"	59"
20	10"	30"	10"	30"	60-3/4"

Attention is invited to the high muzzle velocities obtained with standard powder also to the high pressure on Rd. 19.

VELOCITY DATA

Cannon 10" Gun, M1933 M11, No. 42 Fired by Capt. T. E. Vincent on Jan. 17, 1936

Screen Distances	GUN TO FIRST	HORIZONTAL	CORRECTED TO 1°	BETWEEN	HORIZONTAL	CORRECTED TO 1°
	Coil	125.1'	125.11'	Coil	199.9'	199.92'
	Screen	124.5'	124.51'	Screen	199.9'	199.92'

ROUND NO.	TIME OF FIRING	FORM FACTOR	BOULENH					SOLENOID	
			CARBON GRAPH NUMBER			MEAN INSTRUMENTAL	MEAN VELOCITY	INSTRUMENTAL	MEAN VELOCITY
			1307	1330	1316				
11	11.16	i - .60	2039	2029	2039	2036	2042	2031	2039
12	11.40	"	2245	2245	2239	2242	2249	2241	2250
13	11.57	"	2305	2301	2301	2302	2309	2298	2307
14	12.32	"	2255	2249	2247	2250	2257	2243	2252
15	12.46	"	2271	2261	2261	2264	2271	2260	2269
16	12.58	"	2261	2261	2263	2262	2269	2259	2268
17	1.10	"	2305	2295	2295	2298	2305	2289	2298
18	1.20	"	2253	2255	2257	2255	2262	2252	2261
19	1.29	"	2337	2333	2331	2334	2341	2324	2334
20	1.40	"	2271	2273	2277	2274	2281	2271	2280

PRESSURE DATA

Type of gauge Major and Medium Caliber

Position of gauge Major Caliber in Mushroom Head - Medium Caliber at rear of charge

Metal of crusher cylinder Sept. 12, 1918. Annealed Apr. 4, 1919

Initial compression 0

ROUND NO.	BAND DIAM. INCH.	Maj. Cal.		Maj. Cal.		Med. Cal.		Med. Cal.		MEAN
		GAUGE NO.	PRESSURE 100	GAUGE NO.	PRESSURE 100	GAUGE NO.	PRESSURE 100	GAUGE NO.	PRESSURE 100	
11		A250	281	1189	272	1873	278	5287	261	273
12		889	339	A203	348	1776	324	2805	337	337
13		A285	371	1169	371	4517	367	4866	366	369
14		1094	355	A294	357	1767	337	1801	332	345
15		33	371	A208	373	4916	352	4431	332	357
16		1110	365	1002	352	1816	329	1892	352	350
17		884	364	A204	382	1777	348	5586	355	362
18		A295	348	974	358	1814	329	1795	332	342
19		1707	408	1107	417	3036	400	4089	382	402
20		A225	358	1028	376	5326	350	4316	350	359

Pressures in this report are read and calculated to the nearest one hundred lbs.

Rd.

Band Diameter - Inches

90° Apart

11	10.140	10.139
12	10.135	10.135
13	10.137	10.137
14	10.138	10.138
15	10.141	10.139
16	10.139	10.137
17	10.138	10.137
18	10.140	10.141
19	10.140	10.142
20	10.143	10.141

UNIFORMITY DATA

POWDER LOT	CHARGE		NO.	CHRONO- GRAPH	MUZZLE VELOCITY - F.S.				PRESSURE - LBS.		
	LBS.	OZS.	OF		RDS.	MAX.	VAR.	MEAN	MAX.	VAR.	
					Mean	F.S.	%	DEV.	MEAN	LBS.	%
X-2416-1918	155	4	4	Solenoid	2302	65	2.82	18.5	37300	4500	12.06
				Boulenge	2307	70	3.03	18.5			
X-3545-1918	157	4	5	Solenoid	2262	30	1.33	9.4	34700	2200	6.34
				Boulenge	2264	32	1.41	9.2			

This lot of powder originally tested on July 13, 1931 in 10" Gun, Model 1888, No. 21 (53 rounds previously fired) using the single section bag with a core igniter of 48 ozs. (8-32-8). The mean M.V. (Boulenge) of five uniformity rounds with a charge of 158 lbs. was 2258 f.s., Max. Var. of 30 f.s. or 1.33%, M.D. of 13.0 f.s. The Mean Pressure was 36,187 lbs., Max. Var. of 1700 lbs. or 4.70%. These results are not corrected for erosion. Firings made with 617 lb. C.I.T.P. Shell, Mod. 1911.

METEOROLOGICAL DATA

TIME	BAROMETER	THERMOMETER	HUMIDITY	WIND	
				DIR.	MPH
12 Noon	30.18	33	65	N	7
2 PM	30.16	37	57	N	8

There were no hangfires, flarebacks, misfires or evidence of unconsumed powder on any round, except as noted.

Round 14 - Misfire. Waited fifteen minutes, replaced primer. Second primer misfired. Third primer functioned satisfactorily. Failure of primers due to bad wiring connection on firing lock. Primers removed had not been fired.

It is noted that vent hole in obturator spindle is not straight. It bows up about 1/16" maximum.

Piezo-electric pressures taken on all rounds by Dr. Hodge, Mr. Peck and Mr. Durham from Instrument Section.

T. Z. VINCENT,
Capt., Ord. Dept.,
Proof Officer.

APPROVED:

C. M. WESSON,
Col., Ord. Dept.,
Commanding.

K. F. ADAMSON,
Lt. Col., Ord. Dept.,
Chief Proof Officer,
Gun Testing Division.

ARMED PROVISIONS (GROUND FIRE)

Original Design: Test of Powder Charges for 12" and 14" Guns - Test of Igniters (Firings to establish charge).

Feb. 19, 1936
8833
5
1935-712
12452
5310
471.5/7324
471.5/546
326-2

DEVELOPMENT

Model 1888

CHARGE	MODEL	MANUFACTURER	LOT	NO.
10" Gun	1888 MII	Beth. Steel Co.	42	20
10" Barbetto	1893	Morgan Eng. Co.	6	
Steel High				
Adaptation of Charge	30"	Dethlefsen from	AP	ME
Charge Plate Range		Target		

Project: C.I. Shell, M1911, Tredegar Co. Lot 10480-1-1918 (Rds. 21 - 23, 25, & 28 - 30.) Lot 10480-2-1918 (Rd. 24). Lot 262-1917 (Rd. 27)

None

None

None

P.A. Pyro Lot 443-1918 for 12" Gun, Model 1888-95
D.P. Pyro Lot 701-1-1917 for 10" Gun, Model 1888-95
D.P. Pyro Lot 1086-1918 for 12" Gun, Model 1888-95

Rds. 21 & 24, two section type charge
All other rounds, stacked charges.

20 oss. Black Powder in pad at base of base section

T3 Electric, P.A. Test Lot E-5570-35 (Rds. 21, 23, 25, 27 & 29)
" " " " " B-5570-36 (Rds. 22, 24, 26, 28 & 30)

GENERAL DATA BY ROUNDS

1936	ROUND NO.	TIME OF FIRING	PROJECTILE			POWDER			ELEVATION	FINAL CONDITIONS		Vel. Sol.
DATE			No.	WEIGHT AS FIRED	Seating	Lot	Out of Box	CHARGE WEIGHT		PRESSURE	Velocity	
Feb.			SS	Lbs.	Inches		Ins.	Lbs.	Deg.		Foul.	
19	21	9:40	Y8	617	91-1/16	443	1/8	104	1	10700		1286
	22	10:10	Y9	"	91-1/2	701-A	3/8	117	"	15500	1647	1644
	23	10:30	Y10	"	"	"	7/8	136.5	"	20300	1891	Lost
	24	1:00	Y16	"	91-3/16	1086	1/2	105	"	10800		1311
	25	1:20	Y11	"	"	701-A	1-1/4	166	"	34200	2283	2283
	26	1:48	Y12	"	91-1/4	"	1-3/8	163	"	30500	2271	2249
	27	3:00	Y13	"	"	"	1-1/4	171.25	"	38500	2342	2345
	28	3:22	Y14	"	"	"	1-3/4	163	"	32200	2247	2249
	29	3:28	Y15	"	"	"	2	"	"	32300	2251	2240
	30	3:39	Y17	"	"	"	2	"	"	30900	2252	2245

Recoil (inches) for Rd. 21 = 37-5/8. Rd. 22 = 40. Rd. 23 = 41-1/4. Rd. 24 = 38-3/4. Rds. 25, 26 & 28 = 42-1/2. Rd. 27 = 43. Rds. 29 & 30 = 42.

Rds. 21 & 24, warming rounds.

Temp. of powder = 70°.

RD. NO.	DIA. OF CHARGE INCHES	LENGTH OF SECTION - INS.					TOTAL LENGTH OF CHARGE INCHES
		1	2	3	4	5	
21	9-1/2						54-1/2
22	9-3/8	15-1/8	15-1/8	15-1/8			46-1/2
23	9-3/8	15-1/8	15-1/8	15-1/8	8-1/2		55
24	9-1/2						56
25	9-3/8	15	17	16-3/4	16-1/4		64-1/2
26	9	15-3/4	15-1/2	16-3/4	16-1/2		63-1/2
27	(a)	16-1/4	15-1/2	15-1/4	15	3	64-3/4
28	9	15-3/4	15-1/2	16-1/8	16-1/8		63-1/4
29	9	15-3/4	15-3/4	16-1/8	16-1/4		63-1/2
30	9	15-3/4	15-3/4	16-1/4	16-1/4		63-1/4

(a) 9 inches for Sections 1, 2 & 3. 9-3/4 ins. for Section 4 & 11-1/2 ins. for Section 5.

VELOCITY DATA

Cannon 10" Gun, M1888 MIL, No. 42 Fired by Capt. T.E. Vincent on Feb. 19, 1936

Screen Distances	GUN TO FIRST	HORIZONTAL	CORRECTED TO 1°	BETWEEN	HORIZONTAL	CORRECTED TO 1°
	Coil	127.5	127.51	Coil	197.8	197.81
	Screen	126.8	126.81	Screen	198.0	198.01

ROUND NO.	TIME OF FIRING	FORM FACTOR	BOULENGE					SOLENOID	
			CHRONOGRAPH NUMBER			MEAN INSTRUMENTAL	MISSILE VELOCITY	INSTRUMENTAL	MISSILE VELOCITY
			1307	1330	1316				
21	9:40	1 - .64	Velocity too low - marks off rod					1281	1286
22	10:10		1640	1643	1640	1641	1647	1636	1644
23	10:30		1885	1887	1883	1885	1891	Lost	Lost
24	1:00		Velocity too low - marks off rod					1306	1311
25	1:20		2273	2279	2273	2275	2283	2272	2283
26	1:48		2261	2263	2265	2263	2271	2238	2249
27	3:00		2331	2335	2335	2334	2342	2334	2345
28	3:22		2232	2238	2247	2239	2247	2238	2249
29	3:28		2238	2247	2243	2243	2251	2229	2240
30	3:39		2247	2247	2238	2244	2252	2234	2245

PRESSURE DATA

Type of gauge Medium and Major Caliber

Position of gauge Major Caliber in Mushroom Head - Medium Caliber at rear of charge

Metal of crusher cylinder Sept. 12, 1918. Annealed Apr. 4, 1919.

Initial compression 0

ROUND NO.	BAND DIAM. INS.	Maj. Cal.		Maj. Cal.		Med. Cal.		Med. Cal.		MEAN
		GAUGE NO.	PRESSURE 100	GAUGE NO.	PRESSURE 100	GAUGE NO.	PRESSURE 100	GAUGE NO.	PRESSURE 100	
21		A208	107	20	107	5754	107	5850	107	107
22		A223	171	A243	170	5335	112	5733	168	155
23		250	229	248	223	4575	216	5282	164	208
24		A255	102	A285	111	4217	109	4408	109	108
25		1707	355	974	364	4189	315	3816	335	342
26		1169	347	1199	345	3142	194	1892	332	305
27		1028	389	1215	399	1881	383	1870	367	385
28		1110	345	252	345	1780	283	1842	313	322
29		204	324	295	347	1776	320	1840	300	323
30		1107	339	203	337	1794	298	1771	263	309

Pressures in this report are read and calculated to the nearest one hundred lbs.

Band Diameter - Inches

Rd.

90° Apart

21	10.142	10.1395
22	10.142	10.142
23	10.1375	10.135
24	10.160	10.137 - (Checked)
25	10.147	10.145
26	10.1415	10.150
27	10.139	10.141
28	10.145	10.145
29	10.140	10.1405
30	10.144	10.142

UNIFORMITY DATA

		Muzzle Velocity - F.S.		Pressure - LBS.	
Powder	Charge	Chrono	Max. Var.	Mean	Max. Var.
Lot	Lbs.	rd. Nos.	Graph Mean F.S. %	Dev. Mean lbs. %	
701-A	163	26, 28	Sol. 2246 9 .40	3.3	31500 1800 5.71
		29 & 30	Eoul. 2255 24 1.06	7.8	

METEOROLOGICAL DATA

Time	Barometer	Thermometer	Humidity	Wind	
				Dir.	MPH
10 AM	30.25	16	50	N	12
2 PM	30.23	20	51	WNW	9
4 PM	30.22	22	54	SW	8

No change in gun or carriage since last firing.

There were no hangfires, misfires, flarebacks or evidence of unconsumed powder on any round.

Gun and carriage functioned satisfactorily on all rounds.

T3 Electric Primers, P.A. Test Lots E-5670-55 & -56 were tested in conjunction with this firing. (For reports on firing, see F.R. Nos. 8834 & 8835).

The charge recommended to give a service muzzle velocity of 2250 f.s. is 163 lbs. 4 ozs. with a corresponding pressure of 31600 lbs. per sq.in.

Charge velocity - charge pressure curve attached hereto.

[Signature]
F. A. VICENT,
Capt., Ord. Dept.,
Proof Officer.

APPROVED:

[Signature]
C. M. WESSON,
Col., Ord. Dept.,
Commanding.

[Signature]
K. F. ADAMSON,
Lt. Col., Ord. Dept.,
Chief Proof Officer,
Gun Testing Division.